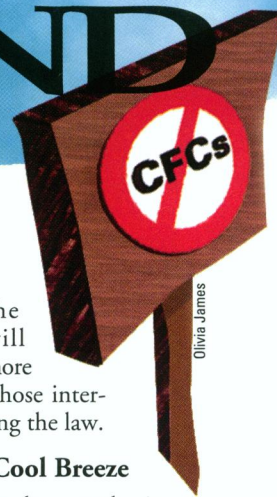


CONTRABAND in the Stratosphere



With the 1 January 1996 deadline for ceasing production of chlorofluorocarbons (CFCs) in the industrialized world rapidly approaching, those who would make money nefariously have found a new way to breach the law. They are smuggling what some estimate to be huge quantities of these compounds, used primarily as refrigerants in air conditioners and refrigerators, into the United States.

Production of CFCs is being phased out because they damage the earth's stratospheric ozone layer, which prevents much of the sun's ultraviolet light from reaching the earth. Degradation of this layer can cause an increase in skin cancer and a reduction of crop yields. Some scientists believe a severe enough decrease could lead to the elimination of many species.

The Largest Hole

The phaseout of CFCs, and its consequences, had its genesis in the 1970s when scientific evidence began to mount that these compounds were damaging the earth's ozone layer. As CFCs escape from junked or faulty compressors and hoses, or when used as solvents, they rise to the stratosphere. There they are transformed by ultraviolet radiation into chlorine atoms, which play a role in catalytic ozone depletion.

Scientists estimate that since the late 1950s, the ozone layer over Europe and North America has decreased by 10%. And just last September the United Nations World Meteorological Organization announced that the largest hole ever measured in the earth's ozone layer—a 3.86 million square mile gap—existed over Antarctica. Figures also showed that this year, the typical springtime decline in ozone levels over the Southern Hemisphere was 10% greater than the previous year.

In an attempt to halt such depletion, an international accord known as the Montreal Protocol was adopted in 1987. Calling for a 50% phaseout of CFCs by 1998, the protocol has been ratified by more than 140 countries. As part of the

original protocol, an agreement was made to continue to meet every few years to review the rapidly evolving science relative to ozone depletion.

When a second meeting was held in London during 1990, clouds were darkening on the ozone horizon. In response, the phaseout was accelerated to 100% by the year 2000. As negative ozone figures kept coming in, that figure too was amended in Copenhagen in 1992, when developed countries agreed to eliminate the production of CFCs as of 1 January 1996, except for a few essential uses. Developing countries received a 10-year extension. The "essential" exceptions allow for the production of CFCs for use as propellants in aerosol sprays for use by asthmatics, and for the use of small quantities in laboratories.

Taxed into Oblivion?

To accelerate the switch to new equipment that can use alternative refrigerants, the United States levied a hefty, annually graduated excise tax on all new and imported CFCs, beginning in 1990. The tax does not apply to CFCs that are recovered and recycled in the United States, since it is presumed they have already been taxed.

During its first year of implementation, the tax was set at \$1.37 per pound of CFC. The tax has risen rapidly to \$5.35 per pound this year and will continue to rise an additional \$0.45 per year. And while the jury is out as to the effectiveness of the tax in speeding the transition, there is little doubt that it has created a large profit margin for those selling contraband product.

With a 30-pound tank of CFC on the legitimate market currently selling for \$250, the tax accounts for over half of the price. Smugglers selling CFCs at or near the market price can pocket what would otherwise go into the government's coffers, in addition to the normal profit. Because equipment built to operate with CFCs cannot use the new refrigerants being introduced, a substantial market for CFCs will remain for some time to come. And, as the supply of CFCs decreases and the tax

increases, the situation will look all the more attractive to those interested in skirting the law.

Operation Cool Breeze

Three agencies have authority over CFC distribution: the Customs Service, the EPA, and the Internal Revenue Service. Each has introduced measures to counter the increasingly lucrative black market. A Customs Service task force by the name of "Operation Cool Breeze" has resulted in the prosecution of four criminal CFC smuggling cases in the United States, each of which was brought to court this year in Miami, Florida.

Miami has become the focus of this operation because "it is a convenient location for this sort of trade," says Thomas Watts-FitzGerald, chief of the Environmental Enforcement Section of the U.S. Attorney's Office in Miami. "We are a major port and a major trading hub for the Central, Latin, and South American markets."

Yet not all of the contraband involved in the cases prosecuted in Miami have come in through that port. Some of the CFCs flowed into the United States through New York and Newark, New Jersey, as well. These cases ended up in southern Florida's venue because the CFCs had subsequently been shipped there under pretense of being routed to another country, when in fact they were diverted into the U.S. market.

The largest case prosecuted to date was that of Irma Henneberg of Fort Lauderdale, Florida, who was found guilty in August of 34 charges relating to falsely manifested cargo. The intent was to conceal the smuggling of almost 4,000 tons of CFCs, with a retail value of \$52 million, and an associated tax loss of some \$32 million. But Keith Prager, assistant special agent in charge with the Customs Service in Miami, says, "We know there are people bigger than her out there." Each count car-

ries a maximum penalty of five years in prison and a fine of \$250,000.

The Henneberg case is typical of the kinds of subterfuge being used by smugglers of CFCs. Because developing countries are still permitted to produce and use CFCs, it is not illegal to ship them through the United States on a tax-free, bonded basis. This status provides that the goods are, for legal purposes, not considered to be in the United States, even though they may be on a pier or in a warehouse on U.S. soil, provided they are passing through from one country to another. "Henneberg was convicted of filing 34 false documents with customs to make it appear as though all of the CFC had been reshipped out of the U.S., when in fact it had not been," explained Watts-FitzGerald.

To date, CFC smuggling has been a white-collar crime. "The key to black market smuggling is to get it introduced into legitimate commerce. The people we have arrested so far have all been associated with the legitimate CFC market," said Prager.

Opening a Loophole

In addition to the excise tax, another governmental regulation on CFCs was implemented in 1990, which some experts feel eventually gave further impetus to smugglers. This regulation involved controls on the amounts of CFCs produced and imported into the United States. Its purpose was to ensure compliance with international control agreements.

The controls used 1986 as a base year and required that CFC production and importation, which had been on a growth curve between 1986 and 1990, be cut back to 1986 levels. To meet this requirement, the EPA gave producers and importers quotas based on their 1986 levels of activity. The total U.S. 1995 production quota is 150 million pounds, 70 million of which is allotted to DuPont, the leading producer of CFCs in 1986. Quota compliance is carefully tracked by the EPA, which requires quarterly activity reports from involved companies.

A move in 1994 to lift the import quota on used CFCs further opened the floodgates to contraband. Until that time, the import quotas applied to both virgin and recycled CFCs equally. Then, as of 1 January 1994, the import quota on used CFCs was lifted. As with the original limitations, this too was done so that the United States would be in compliance with international agreements. As production controls grew ever more stringent, the international community reduced them on used product, both to ease the pain of transition and to prevent the release of used

CFCs into the atmosphere by promoting recycling. As a practical matter, with the EPA no longer watching, smugglers were emboldened to mismark virgin CFCs as recycled material.

"A lot of people have imported virgin refrigerant and called it used, or contaminated it slightly to appear as though it has been used . . . to get around the allowances," said Dave Stirpe, executive director of the Alliance for Responsible Atmospheric Policy (ARAP), an industry group in Arlington, Virginia, composed of producers and users of CFCs and their alternatives.

To plug this loophole, the EPA has recently reentered the picture, this time not with quotas, but with a petition system, requiring importers to gain permission to bring used refrigerant into the United States. "You have to document where it came from and where you are going to recycle it," said Stirpe.

This loophole is not the only threat to the efficacy of the new regulations on CFCs, however. Members of the House Energy and Environment Subcommittee are questioning the impending ban and some have introduced legislation to thwart it. "I am convinced . . . there has not been a sufficient showing of scientific evidence to justify the current and rapidly approaching ban date," said Representative John Doolittle (R-California) in an article in *The Environmental Health Letter*. Doolittle has introduced a bill (HR 2367) to postpone the ban. Representative Tom DeLay (R-Texas) has introduced legislation (HR 475) that would repeal the ban altogether.

An Inundated Market

Those involved in law enforcement are reluctant to speculate as to the sources of the contraband CFCs. The chemicals involved in the cases prosecuted thus far came from England and India, according to Watts-FitzGerald. It is suspected that some people in Russia and China are growing rich from such illegal trade.

Projections as to the quantity of CFCs being smuggled into the United States are also hard to come by. One joint industry-government estimate placed the quantity at 40 million pounds per year, or about 25% of the current production and import allotment under EPA regulations. An industry representative at an EPA-sponsored seminar estimated that 90% of the CFC market in southern Florida was being satisfied with smuggled product, according to Watts-Fitzgerald. Whatever the specific figures, smuggling is having a substantial impact on the marketplace.

Sharon Gidumal, a senior environmen-

tal specialist at DuPont, said her company started noticing something amiss over a year ago, when CFC prices began to drop to an unrealistically low level. "We believed, knowing our costs and those of our competitors, that they could not have made the material for what it was being sold at," she said. "There was a signal being sent to the marketplace that there really was no shortage of CFCs, there's no reason to get out of CFCs. They are plentiful. We felt it was the wrong thing to do for the environment and that businesses that had legitimately invested in CFC alternatives were being harmed by this illegal activity."

The availability of contraband "put the market into a price tailspin," Gidumal added. "It doesn't take much in a commodity business to cause a price war, and that is what this has done . . . the bottom dropped out of the market." As a result, DuPont decided not to produce its full 1995 EPA allowance of CFCs.

The black market has also been causing headaches for those who service air conditioners and their customers because a significant portion of the contraband product is contaminated. The Air Conditioning & Refrigeration Institute in Arlington, Virginia, specifies that recycled CFCs should have no more than 0.5% contaminants, but, "we have found contraband that has come in from off-shore with five, six, and seven percent contaminants," said Simon Oulouhojian, president of the Mobile Air Conditioning Society-Worldwide, an Upper Darby, Pennsylvania-based industry group. Contaminated CFCs can leak through hoses and damage systems, resulting in air conditioning having to be redone, according to Oulouhojian.

Replacements

CFCs are a melange of chemical compounds. Their designations were developed by DuPont in the 1930s as an esoteric code intended to keep competitors from knowing the products' chemical makeup. That code has long since been revealed and is used by the entire industry.

The most widely used compound is CFC-12, also known as R-12, which carries the DuPont trade name Freon. Its primary use is as a refrigerant in residential refrigerators and mobile air conditioners. The automotive industry used about half the worldwide production of CFC-12, or some 125 million pounds per year.

Other CFCs, such as 11, 113, 114, and 115, are used in the production of foam rubber and rigid insulating foam for appliances and construction, and as solvents, especially in the electronics industry. All of these CFCs are being replaced with an

equally confusing number of hydrofluorocarbons or hydrochlorofluorocarbons, known as HFCs and HCFCs, respectively. In the past two years, for example, the automotive industry has made a complete switch to HFC-134a, the replacement of choice for new cars. HCFC-22, which has always been used in residential central air conditioning units, is now also being used in large commercial chillers and in commercial refrigeration.

Yet these replacements for CFCs are no panacea. It is known, for example, that HCFCs can also deplete the earth's ozone layer, albeit at a considerably slower rate than do CFCs. To address this problem, the 1992 meeting in Copenhagen also adopted a complex phaseout schedule for HCFCs. The agreement calls for the reduction of HCFCs in five stages beginning in 2004, with a total phaseout by 2030. And, although HFCs have not been associated with ozone depletion, both they and HCFCs have recently been cited as possible acid rain culprits.

In a paper published in the July 27 issue of *Nature*, T.K. Tromp and colleagues at Atmospheric and Environmental Research, Inc. in Cambridge, Massachusetts, note that atmospheric degradation of several HFCs and HCFCs "is expected to produce trifluoroacetate (TFA), which is removed from the atmosphere mainly by rain." And while the authors find that the concentrations of TFA for the year 2010 will be "well below the concentrations thought to inhibit plant growth," they say that "TFA could attain appreciable concentrations ($>10^2$ μg) in the local surface waters of seasonal wetlands within a few decades."

The paper goes on to state, "The ecological importance of many of these ubiquitous wetlands lies not only in their acting as habitat for many rare and endangered plant and animal species, but also in their use by migratory and wintering waterfowl for foraging and resting during winter and early spring."

A number of alternative refrigeration technologies that can use inert gas as the heat transfer medium are at various stages of development, but when they will be available and economically practical is up in the air.

Work is being done on several fronts to perfect Stirling cycle refrigeration units which can make use of helium. Although the technology is almost ready for commercialization, it is most efficient in small refrigerators and for low-temperature applications. Additionally, the Stirling cycle cannot be used as a drop-in replacement for compressors in existing refrigerators because other refrigeration hardware must be changed as well. For these reasons the U.S. appliance industry has given Stirling a cold shoulder, although it seems to be receiving a warmer reception in Europe.

Another promising refrigeration technology involves a thermoacoustic refrigeration system, which uses sound (see *Innovations*, *EHP*, vol. 102, no. 9). It was invented at Los Alamos National Laboratory in New Mexico with the initial intent of providing cold storage for biological samples aboard space shuttles. Steve Garrett, a primary developer of thermoacoustic refrigeration at the Naval Postgraduate School in Monterey, California, who is now a professor of acoustics at

Pennsylvania State, says he has put much time into the thermoacoustic system because he believes it is an environmental and humanitarian necessity. "Refrigeration is not a glamorous field," he says, "but if you look at it realistically, refrigeration has done more to increase the life span of humans than pharmacology. More people used to die of food poisoning than used to die of the other diseases we can now cure." As a result, he continues, "When developing countries start to make money, the first thing they are going to want is refrigeration. This will create the double pressure of an unmet need and restrictions on chemicals. This leads me to conclude that unless you have an inert gas-based refrigeration system, or a solid-state system, you are at risk with regard to satisfying refrigeration requirements."

But for the time being, the need for CFCs and their questionable replacements will continue, as will the war against those who would make money on illegally trafficking in these compounds. Watts-FitzGerald, for one, doesn't mind. "This is the side of God and the angels," he says. "People who are environmentally concerned look at this and say, 'Hey, this is a good thing to be doing.' And the domestic industry says the same thing for reasons that are persuasive to them. Basically, except for the evildoers, you really don't have anybody saying, 'Why are you doing that?' and in the environmental area that is not always the case."

Victor Chase

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